ILRI RESEARCH BRIEF 43
June 2015

Transgenic agricultural research and product development in Africa: A strategic framework for international and national research

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This brief and its associated full study were supported by the International Livestock Research Institute (ILRI), the International Maize and Wheat Improvement Center (CIMMYT), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the International Rice Research Institute (IRRI), the International Institute of Tropical Agriculture (IITA), the International Potato Center (CIP), and the Africa Rice Center.

Since the first transgenic crop was released in in the world in 1994, cultivation of several varieties has grown rapidly to reach 175 million hectares, more than 10% of the world's arable land, in 27 countries. Adoption and commercialization of transgenic products is growing by 3% per year in developed and developing countries. There is ample evidence that application of transgenic products significantly increases crop productivity and food nutrition and provides higher net financial and environmental benefits. Furthermore, after 20 years of consumption, the products are as safe as any other food.

Transgenic research in CGIAR centres in Africa

In the last ten years, CGIAR centres have invested substantially in biotechnology and subsequently in transgenic research in terms of physical infrastructure, state of the art equipment, and competent human capacity. They now have the physical capacity to carry out a range of biotechnology research from genomics and genetic engineering to field testing of transgenic crops under all safety and environmental contexts.

Funding for such transgenic research in CGIAR is limited to a few mainly bilateral or philanthropic donors and there has not been an active search for funds from multilateral donors or the private sector. This situation is at least partly due to the lack of a coherent and strong voice at the CGIAR level in favor of using transgenic technologies to develop and release biotech products.

Nonetheless, centres are carrying out a considerable number of transgenic research activities that have a potential to contribute to food security and nutrition in Africa. In line with their mandates, they are working on insect resistance, disease resistance, drought resistance, nutrient efficiency and bio-fortification. Most of the gene constructs used by the centres are developed by themselves using elements from the private sector or advanced research institutions. They are generally royalty-free. Some centres are developing their own gene constructs for identified priority traits. In this area, however, they are still perceived by policymakers and a section of the public in Africa to be promoting the interests of multinational companies rather than poor farmers.

So far, no CGIAR centre has released a transgenic product for commercialization in Africa. There has been laboratory and field testing of transgenic cassava, maize, cotton, banana and potato for the last five to 10 years and products are expected to be ready for release and subsequent commercialization and adoption by farmers in the next two to three years. While the centres are posed to transfer

transgenic technologies to national partners for release of biotech products in the next few years, weaknesses in communications, interactions with policymakers and partnerships with regional, sub-regional and national research hamper deployment and commercialization.

Regarding livestock transgenic research, there is only one project at the International Livestock Research Institute (ILRI) on trypanosomiasis resistance in cattle. Unlike crops, there is very little funding for livestock transgenic research and this single research activity at ILRI may not have adequate funding to reach the ultimate conclusion.

Definitions

Transgenic research is part of the science of biotechnology. Biotechnology is 'any technological application that uses biological systems, living organisms or derivatives thereof to make or modify products or processes for use'. Agricultural biotechnology is any technology application that uses biological systems, living organisms or derivatives thereof to make or modify products or processes for use in agriculture (crops, livestock, fisheries and trees).

Genetic engineering is the group of techniques used to cut up and join genetic material especially the DNA from one or more species for introduction to an organism in order to change one or more of its characteristics. It is the process of creating new gene constructs for a desired trait and is commonly referred to as 'modifying genotypes, hence phenotypes by transgenesis'[1].

Transgenesis is the process of introducing an exogenous gene either from an unrelated or related organism into a living organism so the organism exhibits new properties and transmits those properties to its offspring. It introduces a 'gene or genes into animal or plant cells which leads into transmission of input gene (transgene) into successive generations'[1].

Transgenic research starts from the science of genomics which applies DNA sequencing methods and bioinformatics to sequence, assemble and analyse the function and structure of genomes so as to better understand all genes and their interrelationships in order to identify their combined influence on the growth and development of the organism. Genomics provides the information required for genetic engineering and gene discovery for desired traits. Once genes have been discovered and gene constructs constituted for a desired trait, organisms are genetically transformed to acquire the traits through transgenesis.

The products of transgenesis are commonly referred to as genetically modified organisms (GMOs). Transgenic products result from new knowledge of the genome, functional analysis and genetic engineering or genetic transformation for desirable traits in plants and animals.

FAO. 2013. Biotechnologies for Agricultural Development: Agricultural Biotechnology in Developing Countries. Rome: FAO. www.fao.org/biotech/biotechnology-glossary

Transgenic research in national and regional institutes

In the last decade, Africa has established relatively strong regional and sub-regional organizations in agricultural research, dealing with advocacy, policy development and coordination of research activities. Organizations like the Forum for Agricultural Research in Africa (FARA) and its sub-regional member associations are becoming major players in agricultural research for development and they attract reasonable donor support for advocacy, policy and agenda-setting. These organizations have identified the lack of human capacity, lack of funding and a non-conducive policy environment as the main impediments for transgenic research and product deployment in Africa.

Others institutes such as the African Agricultural Technology Foundation (AATF) and the ILRI-Biosciences East and Central Africa (BecA) Hub are key players in technology brokerage and they provide access to modern bioscience infrastructure for transgenic research in Africa.

All African countries except three have ratified the Cartagena Protocol on Biosafety in the Convention on Biodiversity Conservation. The protocol sets the international framework by which governments could develop their own biotechnology policies, biosafety legislation and regulations. While progress has been slow, a critical mass of African countries now has national policies, legislation and, in some cases, regulations to enable transgenic research and the deployment of its products. Policymakers seem well aware of the advantages and concerns of GMOs. Generally, countries that have not made much progress with biotechnology policies and biosafety legislation are constrained by lack of capacity, pressure from anti-GMO activists and lack of political will.

Out of the 12 countries researched for this study, eight have biotechnology policies and biosafety legislation in place, two have biotechnology policies and are at advanced stages of legislating biosafety bills and two have neither a biotechnology policy nor a biosafety bill. All 12, except those countries without biosafety policies, have established mechanisms and institutions to regulate biotechnology research and the deployment of transgenic products. But some may not have the capacity necessary to carry out the regulatory function effectively.

Many of these countries have the critical mass of physical infrastructure needed for transgenic research, in terms of buildings for laboratories and offices. However, they lack equipment and technical staff. The most serious constraints for transgenic research in Africa are the lack of scientific capacity, lack of funds and the threat of anti-GMO activists. While some of the countries have some scientists able to partner with CGIAR centres on adaptive transgenic research, only South Africa has the scientists able to take part in basic transgenic research activities.

Despite the lack of human capacity and financial resources, transgenic research activities are taking place in nine out of the 12 countries. They are generally led by CGIAR centres, with a few by the private sector. Except in South Africa, there is no real investment in transgenic research by national governments and all research activities are supported by donors and the private sector.

Unlike crops, livestock transgenic research in Africa is very weak. The policies and legislation in place do not seem to cater for transgenic livestock research and deployment of livestock transgenic animals. Except in Kenya and South Africa, policymakers and lawmakers do not anticipate a role for transgenic livestock research and products in livestock productivity. There is neither the physical nor the human capacity to undertake or participate in transgenic livestock research in the countries in this study. The policymakers see this type of research as too advanced for their meagre human capacity and the national research systems have no plans to undertake this type of research in the near future.

The most critical barriers to transgenic research and the application of biotechnology tools in Africa are (i) lack of scientific capacity to carry out transgenic research and communicate results to farmers and policymakers; (ii) lack of financial resources not only for transgenic research but also for agricultural research and development in general; (iii) inadequate policies, legislation and regulations to guide biotechnology and consequently transgenic research and development; (iv) inadequate capacities and inefficiencies of regulatory institutions responsible for transgenic research; (v) ambivalent political positions on research, adoption, commercialization and consumption of GMOs and (vi) anti-GMO lobbying by civil society.

India's experience and progress in transgenic research provides very useful lessons for African countries. Unlike Africa, India has an immense human and physical capacity in transgenic research accumulated over time. India is also investing substantially in transgenic research to position itself to be a major global player. As in Africa, despite this tremendous experience, only one trangenic crop has been released in India but several others are in the pipeline. India also has active anti-GMO lobby groups which challenge transgenic research and deployment, even in courts. So far, the research system in India is not deterred or distracted.

Vision and objectives for transgenic research in Africa

Within CGIAR, the strategic vision of transgenic research is derived from a CGIAR Strategic Results Framework. The vision of CGIAR focuses on reduction of poverty and hunger, improvement of health and nutrition, and ecosystems resilience through high quality international agricultural research, partnerships and leadership.

Aligning to this, a vision of transgenic research for CGIAR centres is 'to increase crop and livestock productivity and quality for wealth creation, food and nutrition security, and ecosystem quality in Africa through transgenic biotechnology research, partnerships and leadership.'

Since transgenic research is a relatively new tool and is a small component of the research portfolio of CGIAR, the contribution of transgenic products to the vision of CGIAR is expected to be small, but strategic and impact-driven.

The strategic focus for transgenic research by CGIAR centres should be institutional support development and implementation of research activities, capacity development and creating an enabling environment for deployment, stewardships, commercialization and adoption of transgenic technologies by resource-poor farmers. Transgenic research by CGIAR centres in Africa should embrace the following objectives:

- Improve planning, implementation efficiency, policy and communication of transgenic biotechnology research in Africa.
- Develop crop varieties with novel traits for increased productivity, economic benefits and nutritional value.
- Develop livestock breeds with novel traits for increased productivity and economic benefits.
- Build capacity in national agricultural research systems for transgenic research and services in Africa.
- Enhance the deployment, stewardship, commercialization and adoption of transgenic products in Africa.

Strategic process and actions

To achieve these objectives, centres and partners need to adapt the following new strategic processes and actions to support transgenic agricultural research in Africa:

Institutional support

- Establish a CGIAR biotechnology strategy support, planning and oversight group.
- Review institutional biotechnology policies in consultation with partners.
- Jointly communicate and interact with public and policymakers on transgenic products.
- Jointly review and plan transgenic field research activities.
- Mainstream regional advocacy, biosafety capacity building, policy and baseline activities into regional and sub-regional organizations.

Crops research

- Enhance support to ongoing transgenic research activities in Africa to release and commercialise products.
- Diversify donor funding for transgenic research in Africa.
- Deploy transgenic research products of orphan food crops being developed by centres to Africa.
- Develop a program for bio-fortified rice for Africa.
- Develop binding partnerships with regional and sub-regional organizations to be their agents for basic transgenic research and implementation.

Livestock research

- Enhance the ongoing research on trypanosomiasis resistance in cattle for Africa.
- Revamp basic (genomics and sequencing) livestock biotechnology research for gene discovery.
- Initiate transgenic livestock research for novel traits into small ruminants and poultry.

Capacity development

- Mainstream capacity building for national agricultural research systems into ongoing transgenic research activities.
- Develop and support training needs assessment for biotechnology research in national agricultural research systems.
- Develop and support training and capacity training programs in partnership with national agricultural research systems and universities.
- Support regional bioscience research and capacity building entities in Africa.
- Develop South-South cooperation programs between the national agricultural research systems and sub-regional organizations in Africa.

Deployment, stewardship, commercialization and adoption of transgenic products

- Mainstream field trials, release and stewardship of transgenic products into national agricultural research systems and the private sector in best-bet, ready countries.
- Strengthen partnerships between centres and national agricultural research systems and the private sector for release and stewardship of transgenic products.
- Participate in regional, sub-regional and national policy and communication fora.
- Mainstream release and commercialization, intellectual property and trade related issues in transgenic research programs.

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June 2015